Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

THE PHENOMENON OF FERTILIZATION IN THE FLOWERS OF MONARDA FISTULOSA.

BY IDA A. KELLER, PH. D.

Although a conspicuous flower and an irregularly shaped corolla are apt to lead one to suspect that these are particular adaptations to aid in securing cross fertilization, yet on the other hand close observations have shown that these characteristics do not always imply the desire to attract insect visitors. Nor is the idea that close fertilization is only resorted to when the arrangements made to favor cross fertilization have failed in their mission, perhaps as generally true as is often supposed. The discovery of fertilization in the bud, recently described by Mr. Meehan in *Malva rotundifolia* tends to confirm this view. Here fertilization, as Mr. Meehan has shown, takes place in the bud, and the case is not exactly as described by Prof. Müller, who says: " As examples of the countless ways in which plants revert to self fertilization in default of sufficient insect visits, I may mention the following:—In some dichogamic flowers the stigmas curl back upon the anthers or other parts which still retain some pollen,"[1] and as an instance of this he gives the flowers of *Malva rotundifolia.* But in the flowers of this plant examined by Mr. Meehan, the deposition of pollen on the stigma lobes and the formation of pollen tubes begin before the stigma lobes are curled backward.

Aside from those cases to which the term cleistogamic is particularly applied: those in which two forms of flowers are produced, one form being small, odorless, inconspicuous and closed, in addition to the ordinary large conspicuous flowers, which are also much less fertile, numerous instances are known where fertilization takes place in the unopened bud. The term cleistogamy might with equal propriety be extended to all cases where fertilization takes place before anthesis, even with the entire absence of any dimorphism, and will perhaps in time be so extended.

An interesting form showing such close fertilization is found in the buds of the ordinary flowers of *Monarda fistulosa.* The figures of Plate XV represent different stages of the opening of the flower. Beginning with Fig. A, the oldest flower represented, we notice that the corolla is about to wilt, the stamens have shrivelled up, but the style projects at full length from below the upper lip of the corolla; no pollen was noticeable on the lobes of the stigma, but the lobes are widely separated. The next younger flower, B, shows the corolla still fresh, the style not yet quite exserted, the stamens have wilted, and the stigma lobes are separated. The next younger flower, C^1, has opened and the filaments, which have a fold in the bud, are straightening out; the style is quite hidden under the upper lip of the corolla. Fig C^2 represents the style taken out from the upper lip; the lobes of the stigma are *closed.* Fig. D, the next stage, represents a bud just opened, and the stamens beginning to protrude.

---

[1] Prof. Herman Müller. The Fertilization of Flowers. Translated by D'Arcy V. Thompson, p. 591.

Fig. E^1 represents a closed bud, ready to open. E^2 represents this bud forcibly opened, and E^3 shows the anthers united. Fig. F is about the same as E, but here in F^2 a portion of the corolla is removed in such a manner as to expose the relative position of anthers and style in the closed bud. It was found that the anther cells had discharged their pollen, that the lobes of the style were widely separated, and, in the case represented in the drawing, the longest lobe of the style was actually dipping into the upper cell of one of the anthers. The style, it will be observed, curves over the top of the anthers. Its shape at that time is best seen in Fig. F^3 which represents the style (upper portion) taken out from the bud F. Fig. F^4 represents the same style much more highly magnified, with the pollen attached to it.

I have noticed pollen discharged in small quantity in extremely young buds, but at present it is impossible for me to say just at what period fertilization begins. The stigma lobes are separated at a very early period. One fact which leads me to suspect that fertilization begins at this early period is the presence of peculiar masses which strongly resemble the protoplasmic contents of the pollen grains. These I have represented in C^3, the style of C^1 highly magnified. These masses could not be detected in fresh material, but were invariably found in styles of flowers which had been kept in alcohol. They are inside of the tissue of the style and usually found throughout its entire length, although they are more or less irregularly distributed. To the right of C^3 are three pollen granules, and on comparison with these the yellowish masses in the style seem as a rule smaller, often more or less disorganized, and frequently lumped together. A final decision as to the character and significance of these masses can be arrived at only after a more careful investigation than I have been able to make so far. This is reserved for some future time.

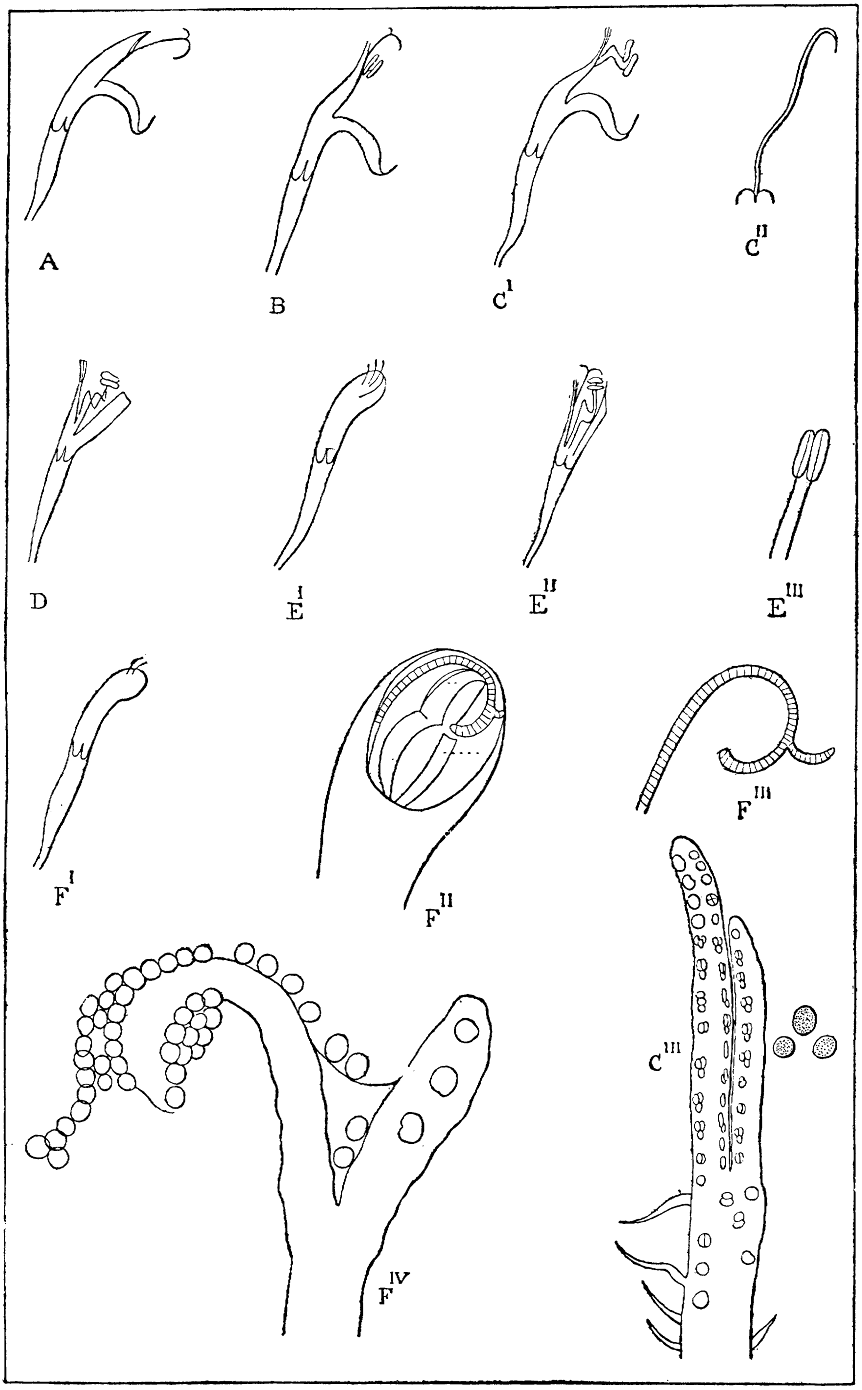
If it can be taken for granted then that the flowers of *Monarda fistulosa* present the phenomenon of close fertilization in the bud, the question naturally arises, why should the flowers expand, protrude the stamens, and finally the style? This question must as yet remain unanswered. In case of the Fumariaceæ, where, with the exception of *Hypecoum*, according to Hildebrand,[2] close fertilization is unavoidable, the anthers shrivel up as soon as they have deposited their pollen on the stigma, while in the case of *Monarda fistulosa* they become exserted after they have deposited some of their pollen on the style, and remain so exserted for a certain period of time. The same is true of the style. This seems particularly strange in view of the fact that the style usually wilts very shortly after fertilization is accomplished, instead of showing the phenomena of growth and expansion here witnessed. But another observation of Hildebrand's should here be mentioned. In his experiments on *Escholtzia californica* he noticed that in case of fertilization with the pollen from another flower, the petals soon fell off and the style quickly wilted, while in case of fertilization with the pollen from the same flower, the petals dropped at a much later period, and the style remained fresh much longer.[3]

The above observations on *Monarda fistulosa* were made in November; as the time of blooming of this plant extends over a long period, it is possible that it may vary in its method of fertilization at different times of the year. The species, according to Gray, is extremely variable. It is represented in addition to the type by well marked forms of var. *rubra* Gray, var. *media* Gray, var. *mollis* Benth. The chief differences being in the flower, interesting variations in the methods of fertilization may be looked for.

---

[2] F. Hildebrand. Uber die Bestänbungs vorichtungen bei den Fumariaceen. Pringsheim's Jahrb. für wissen. Bot., VII, Band, p. 455.

[3] Uber die Bestänbungs vorichtungen bei den Fumariaceen Pringsh.'s Jahrb. für wis. Botanik, Bd. VII, 1869–1870, p. 466.



KELLER, MONARDA FISTULOSA.